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NAVAL MEDICAL RESEARCH UNIT DAYTON

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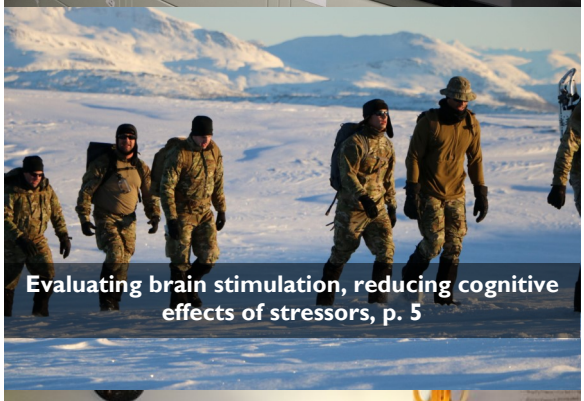
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Aviation operating environments, mitigating low-intensity laser threat

Lt. Cmdr. Micah Kinney, aerospace optometrist, is co-lead in a joint Navy-Air Force response to the USCG's request for assistance in mitigating the threat posed to flight safety and search and rescue operations by high-powered handheld lasers. (U.S. Navy photo by Megan Mudersbach/Released)

By: Dr. Michael Reddix & Lt. Cmdr. Micah Kinney

The Naval Medical Research Unit Dayton (NAMRU-Dayton) Vision Science Lab is evaluating low-intensity threat laser eye protection (LIT-LEP) for use in aviation operating environments. Dr. Michael Reddix, senior research psychologist, and Lt. Cmdr. Micah Kinney, aerospace optometrist, are leading this joint-service initiative in response to the U.S. Coast Guard (USCG) Office of Aviation Forces' request for assistance in mitigating the threat posed to flight safety and search and rescue operations by high-powered handheld lasers.

The rate of nighttime visible-laser cockpit illumination incidents in commercial, military, law enforcement, air ambulance, and general aviation in the continental United States continues to increase. In 2016, 7,442 incidents of aircraft laser illumination were reported to the Federal Aviation Administration (FAA), with 6,753 illumination events reported for 2017. This represents an approximately 25 fold increase in aircrew-reported illumination events compared to 2005, which reported 283 events. Regarding the U.S. Navy and Marine Corps, 249 lasing events were reported for fiscal 2015-2017. The USCG reported 159 illumination events between fiscal 2011 and 2015.

Handheld lasers can produce levels of solar radiant energy that exceed the maximum FAA exposure recommendations. Non-lethal continuous wave (CW) laser exposures can produce veiling glare, obscuring a significant portion of an aircraft windscreen while reliably reducing speed and accuracy of responses to aviation-relevant visual tasks during critical phases of flight. These factors are also capable of producing visual impairments such as temporary scotoma or a temporary disturbance in vision.

In order to meet USCG laser-threat mitigation requirements, NAMRU-Dayton partnered with the U.S. Air Force Research Laboratory's Materials and Manufacturing Directorate, Photonic Materials Branch (AFRL/RXAP) to design, manufacture, and evaluate a low-cost LEP spectacle with the goal of mitigating safety of flight risks primarily associated with the laser aircraft illumination events.

The LEP solution is designed to be compatible with both fixed- and rotary-wing USCG avionics.

After conducting various evaluations findings demonstrated no safety of flight issues. The team completed manufacturing quality assurance, optical engineering and psychophysical evaluations, and preliminary flight simulator and ground testing. Additional evaluations included in- and out-of-cockpit color symbol discrimination, acceptable head-up display and night-vision device compatibility, and a USCG Aviation Training Center assessment and recommendation for flight acceptance testing, August–September, 2018.

Although the prototype was designed specifically for USCG aircraft, this new technology could be applied to commercial and general aviation, air ambulance, and law enforcement aviation laser-safety requirements.

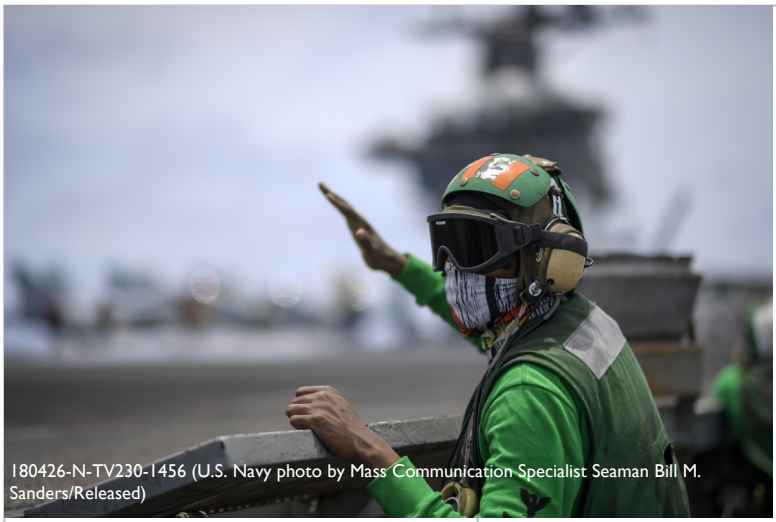
Related reports:

Kinney, M.J., Reddix, R.D., Funke, M.E., Sapp, D.R., McCann, B.M. ((June, 2018). USCG Aircrew Evaluation of Low-Intensity Threat Laser Eye Protection: MH-60T, MH-65D, HC-144 Simulator and Static Aircraft Evaluations. Retrieved from Defense Technical Information Center <https://www.dtic.mil/DTICOnline/downloadPdf.search?collectionId=tr&docId=AD1052966>.

Reddix, M.D., Funke, M.E., Kinney, M.J., Bradley, J.L., Irvin, G., Rea, E., Kunkle, C.L., McCann, M.B., Gomez, J. (June, 2018). Evaluation of Aircrew Low-Intensity Threat Laser Eye Protection. Retrieved from Defense Technical Information Center <https://www.dtic.mil/DTICOnline/downloadPdf.search?collectionId=tr&docId=AD1052962>.

Story Link

Focusing in: Noise impact on hearing loss



180426-N-TV230-1456 (U.S. Navy photo by Mass Communication Specialist Seaman Bill M. Sanders/Released)

By: Andrew Keebaugh

Protecting United States service members from noise-induced hearing loss is an ongoing focus of the Department of Defense as hearing loss is the number one disability among veterans. Noise exposure in the military can occur 24 hours a day, such as during flight operations, even in off-duty areas. For example, noise measurements in berthing areas of aircraft carriers have been found to exceed current hearing protection standards during flight operations, bringing into question what constitutes acceptable noise levels during off-duty periods following occupational noise exposures. More research is needed to understand what level of noise is sufficient during daily "effective quiet" periods that would allow for auditory recovery and prevent permanent hearing loss.

Researchers from Naval Medical Research Unit - Dayton's (NAMRU-Dayton) Environmental Health Effects Laboratory (EHEL) are evaluating the impact of military-relevant 24 hour noise exposures on hearing loss.

A project funded by the Navy In-House Laboratory Independent Research Program (ILIR) is studying the effects of elevated steady noise levels during a recovery period (simulating the off-duty shipboard environment) after an eight hour high noise exposure at the occupational limit of 85 decibels time-weighted average. These noise exposures would not be expected to cause damage on their own, but in combination could impede auditory recovery and lead to permanent hearing loss after four weeks of exposure.

A separate study funded by the Defense Health Agency (DHA/J9) is focusing on the effects of steady and impulse noise exposures during the daily recovery period following occupationally relevant exposures to combined noise and inhaled chemical exposures.

There are many factors that can complicate risk assessment when it comes to noise exposure. Noise exposure itself is often complex and may consist of brief high-level noise impulses, in addition to steady elevated noise levels. Additionally, breathing in certain chemicals, such as the volatile organic compounds (VOCs) present in jet fuel, may worsen noise-induced hearing loss. It is unknown how these complex noise and chemical exposures will impact permanent changes in hearing, especially taking into account …..

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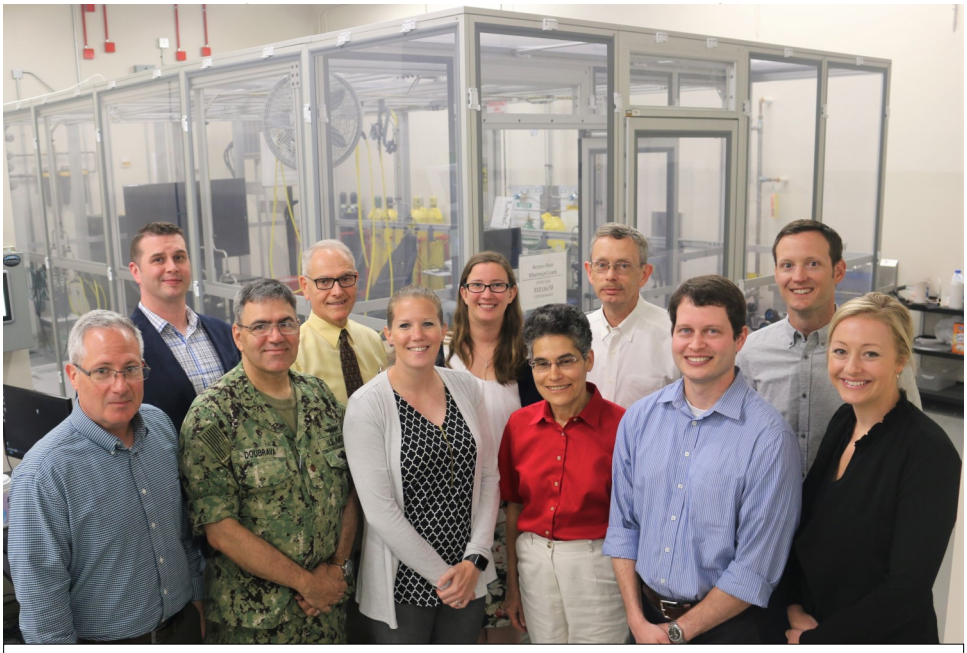
Story Link

NAMRU-Dayton team tackles naval aviation's top priority: Physiological episodes

By: Dr. Richard Arnold, Director, NAMRL, NAMRU-Dayton



Members of the Environmental Physiology team at the Naval Aerospace Medical Laboratory, NAMRU-Dayton are responding to in-flight physiologic episodes by investigating various altitude effects that may contribute to the safety issue. The team is standing in front of the Reduced Oxygen Breathing Environment (ROBE) housed at NAMRL. The ROBE is designed for multiple subject exposure and can replicate 34,000 feet in altitude. (U.S. Navy photo by Megan Mudersbach/Released)

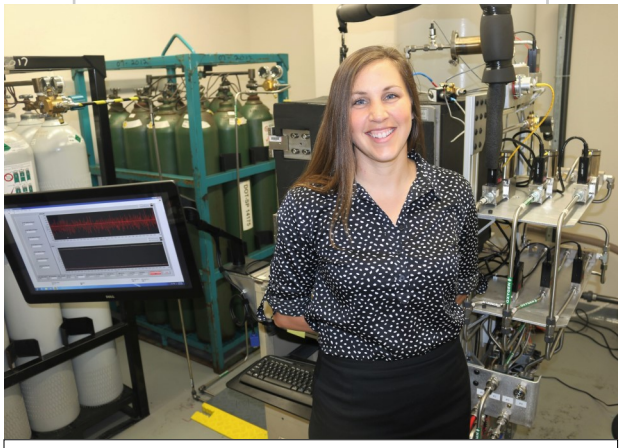
Protecting aircrew against a wide range of physiologic challenges posed by the tactical aviation environment is a primary driver of research priorities at Naval Medical Research Unit – Dayton (NAMRU-Dayton). With the growth of unexplained physiologic episodes (PE) being reported across U.S. Navy and U.S. Air Force aircraft platforms, NAMRU-Dayton is responding to the challenge. We are rapidly expanding our environmental physiology research capacity by adding experienced altitude effects researchers and developing new laboratory facilities.

The Naval Aerospace Medical Research Laboratory (NAMRL) at NAMRU-Dayton expanded its research portfolio of PE related studies from about five per year prior to fiscal year 2017 to 25 unique PE related research protocols in fiscal year 2018. Research topics include the effects of barometric pressure changes, the effects of variable breathing gas mixtures, and the effects of breathing resistance on aircrew physiology and performance. The lab is developing and testing a range of physiologic, gas, and chemical sensors for use as in-flight PE detection and mitigation tools.

NAMRL is not alone in the fight to understand and mitigate PEs. The Environmental Health Effects Laboratory (EHEL) at NAMRU-Dayton is conducting research to characterize the potential role of chemical contaminants in PEs. EHEL is collaborating with NAMRL to conduct more extreme environmental exposure protocols than NAMRL can accomplish through its human -use research program.

NAMRU-Dayton is strengthening collaborative relationships with Department of Defense laboratories including Naval Medical Research Center, Naval Health Research Center, Naval Submarine Medical Research Laboratory, NAMRU- San Antonio, Naval Air Warfare Center (Aircraft and Training Systems divisions), Navy Experimental Diving Unit, USAF 711th Human Performance Wing, and US Army Aeromedical Laboratory.

Additionally, NAMRU-Dayton is working with academia and industry partners including Case Western Reserve University, Florida Institute for Human and Machine Cognition, and KBRwyle to conduct research and development (R&D) in response to the rise of in-flight physiologic episodes.



Stephanie Warner is a biomedical engineer and principal investigator on a number of altitude effects research efforts. Shown to the right is NAMRU-Dayton's Sensors Laboratory, which replicates the aviation environment to evaluate the effectiveness of each sensor when exposed to the operational environment and identify specific areas for improvement. (U.S. Navy photo by Megan Mudersbach/Released)

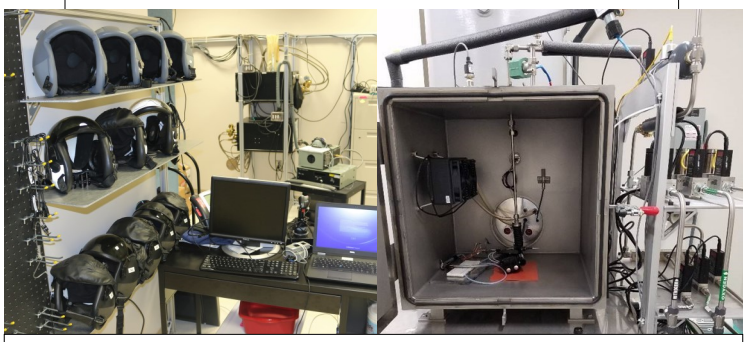
The command continues to receive R&D support from long-term line stakeholders like NAVAIR. More recently, non-traditional sponsors of aeromedical research such as Defense Health Agency (DHA) and the Navy Bureau of Medicine and Surgery (BUMED) have enabled the lab to mount a substantial response to the threat of PEs to DoD aircrew.

In support of the lab's planned research NAMRL is constructing a new respiratory physiology laboratory that will aid studies on the effects of four factors; (1) variable breathing gas mixtures, (2) in-line breathing resistance, (3) breathing gas pressure and flow disruptions, and (4) flight equipment fit on aircrew physiology and cognitive function. To support these initiatives NAMRL is building several aircraft-specific life support system (LSS) simulators to reproduce the breathing environments of the T-45 and F/A-18 aircraft, for example.

Due to this surge in PE-related research NAMRL has added a number of senior scientific staff with experience in respiratory physiology research. Most recently Drs. Dan Warkander and Barbara Shykoff joined the team, bringing collectively over 40 years of research experience in respiratory physiology and life support system design through their previous work at University of Buffalo and Navy Experimental Diving Unit.

Such additions to the staff bolster an already excellent cadre of altitude effects researchers.

Research experts at NAMRU-Dayton are equipped to lead the Navy's research response to in-flight physiologic episodes our military is facing.



Left: Altitude research lab equipped with five reduced oxygen breathing devices (ROBD), which are portable, computerized, gas-blending instruments that deliver hypoxic air mixtures through a standard aviation mask without exposing subjects to environmental pressure changes.

Right: An inside look of the small hypobaric environmental chamber housed in NAMRU -Dayton's Sensors Laboratory.
(U.S. Navy photo by Megan Mudersbach/Released)

Story Link

EHEL's bench grows

By: Dr. Karen Mumy, Director, EHEL, NAMRU-Dayton

The Environmental Health Effects Laboratory at NAMRU-Dayton. In 2018, EHEL experiences a 300% increase in awarded research studies and funding in addition to a diversification of its research portfolio. (U.S. Navy photo by Megan Mudersbach/Released)

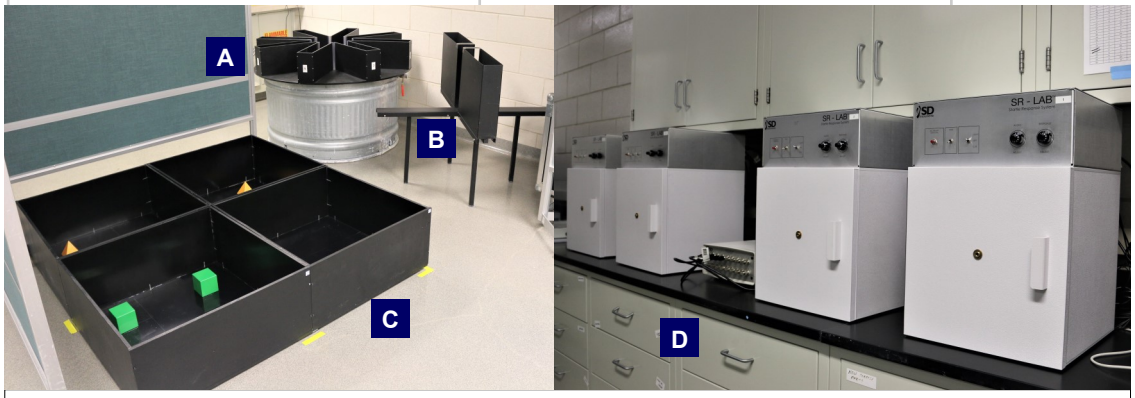
The Environmental Health Effects Laboratory (EHEL) at Naval Medical Research Unit - Dayton (NAMRU-Dayton) has a rich history in dealing with austere environments. The research group originally stood up in 1959 as the "Navy Toxicology Unit" and was charged with assessing potential health effects associated with exposure to unique operational environments. Many of those environments did not have a correlate in the public sector, such as nuclear submarines and military shipboard environments, and were therefore not being studied by those charged with protecting civilians. As EHEL nears its 60th anniversary, the lab continues to study many of the same environments, along with a host of new challenging environments, through much more advanced and sensitive scientific approaches and instrumentation, allowing deeper understanding of how these environments impact service member health and performance.

2018 became a banner year for EHEL, as we saw a 300% increase in awarded research studies and funding over recent years, as well as a diversification of its research portfolio. While the lab holds the toxicology program of record under the Navy Bureau of Medicine and Surgery (BUMED), "environmental health" encompasses much more than the classical toxicology involving the study of chemicals. Though EHEL remains primarily focused on the effects of exposure to chemicals, with a unique emphasis in inhalation toxicology, other environmental stressors have also become the focus of many research studies. These environmental stressors include hazards that service members face every day, such as extreme temperatures, altitude and noise.

Further, EHEL continues to diligently broaden our battery of health outcome assessments by incorporating additional neurological and physiological testing. This includes the integration of a number of real-time neurological tests performed with laboratory animal models during exposure. This requires the creative adaptation of many tests because these types of assessments have historically been performed after exposure.

Real-time assessments are designed to better predict effects on service members that may occur and affect health or alter performance in the moment while performing a task or mission. Many of these effects may rapidly resolve once the exposure stops, thereby making it very difficult to "catch" these effects in a research setting in an effort to understand what exactly is contributing to the effect and how.

These new approaches and research focus areas are made possible by EHEL's exceptional research team consisting of 36 military officers, civilian employees and contract employees, 11 of which joined the team in 2018. Altogether, EHEL has expertise that range from engineering, computer programming and chemistry, to psychology, physiology, audiology and, of course, toxicology - where it all began nearly 60 years ago.



EHEL's neurobehavioral lab houses: (A) Radial Arm Maze, which assesses spatial learning and memory (B) Elevated Plus Maze, which is used to assess anxiety in laboratory animal models, and (C) Novel Object Recognition, which evaluates learning and memory, and (D) Acoustic Startle Reflex systems for measuring brain stem function and sensory motor gating to discriminate stimuli. (U.S. Navy photo by Megan Mudersbach/Released)

Story Link

continued from pg. 2 ## Focusing in: Noise impact on hearing loss

…..elevated noise levels during the auditory recovery period.

NAMRU-Dayton is currently developing a system that can study steady and impulse noise exposure for 24 hours a day with or without chemical exposures for a portion of that time. A noise generation system had been developed for prior studies at the lab, but the system was limited to use with short-term exposure chambers and could only generate steady noise. EHEL toxicologist, Dr. Andrew Keebaugh, is working with Captain Lester Morales, a student at the Air Force Institute of Technology, to design and construct a noise exposure system capable of generating high-decibel impulse noise for use in these studies.

We are also expanding our auditory testing capability to conduct functional assessments of peripheral and central hearing. Dr. Rachel Howes, an audiologist, recently joined the NAMRU-Dayton team to assist EHEL with audiology measurements and analysis.

The research team at EHEL is committed to protecting our service members from noise-induced hearing loss by using our unique facilities to support the effort.

Evaluating brain stimulation, reducing cognitive effects of stressors

170205-N-N0901-002. RAMSUND, Norway (U.S. Navy Photo by Lt. j.g. Seth Wartak/Released)

By: Dr. Joyce G. Rohan

Transcranial direct current stimulation (tDCS) is a type of non-invasive brain stimulation with a promising potential as a therapeutic method as it can partially relieve neurological symptoms associated with various disorders ranging from depression and post-traumatic stress disorder (PTSD) to Alzheimer's disease. There are investigations into the potential use of tDCS in enhancing performance of healthy subjects. Although tDCS has shown to lessen neurological impairments and enhance cognitive performance, exactly how it works remains unclear.

For the past several years, the Environmental Health Effects Laboratory at Naval Medical Research Unit Dayton (NAMRU-Dayton) has had an ongoing collaboration with U.S. Air Force 711th Human Performance Wing, Airman Systems Directorate, Battlespace Visualization Branch (711 HPW/RHCPA) at Wright-Patterson Air Force Base, Ohio. Funded by Air Force Office of Scientific Research, the joint team is studying how tDCS causes its effects, on a cellular level, using a laboratory animal model.

An obvious militarily-relevant benefit of this non-invasive brain stimulation is its potential use as a countermeasure to reduce cognitive deficits resulting from harsh environmental conditions or potential chemical hazard exposures that military personnel may face during training or deployment. Such an application of tDCS has not yet been addressed. NAMRU-Dayton, in collaboration with 711 HPW/RHCPA, has the opportunity to explore this possibility.

Recently, NAMRU-Dayton obtained funding from the Defense Medical Research and Development Program (DMRDP) to evaluate the potential use of tDCS to counteract and/or reduce negative neurological effects of extreme temperature exposures. Another main goal of this multi-year study is to characterize sex-dependent differences in the ability of tDCS to alter neurological function, as well as any sex-dependent differences with exposure to extreme temperature.

Additionally, NAMRU-Dayton obtained additional funding from the Defense Health Agency to evaluate the potential use of tDCS to reduce negative neurological effects resulting from exposure to various chemicals.

NAMRU-Dayton plans to continue our efforts in understanding how tDCS works with the central nervous system. Understanding how tDCS works on the brain is essential to develop a safe guideline for tDCS application. Establishing a safe implementation strategy for tDCS that can reduce, treat or prevent adverse neurological effects of environmental stressors and/or chemical exposures is an important undertaking that can help ensure the health and safety of our military personnel as they carryout missions.

Story Link

Vestibular research expands at NAMRU-Dayton

By: Dr. Richard Arnold, Director, NAMRL, NAMRU-Dayton

Dr. Richard Arnold (*left*), NAMRL director and Dr. Dan Merfeld (*right*), NAMRL senior vestibular scientist, discuss joint vestibular research capabilities between military and academic organizations. (U.S. Navy photo by Megan Mudersbach/Released)

The effects of vestibular phenomena on operator health, readiness, and performance are numerous. From traumatic brain injury-related balance dysfunction to motion-sickness to pilot spatial orientation, the relevance of the vestibular system to key operational problems is significant. After several years of re-building under the Naval Medical Research Unit Dayton at Wright-Patterson Air Force Base, Naval Aerospace Medical Research Laboratory's (NAMRL) vestibular research program is poised to regain its historical position as a world leader.

NAMRL, originally located on Naval Air Station Pensacola, enjoyed a long and distinguished position at the forefront of vestibular research for many years. Such figures as Capt. Ashton Graybiel and Dr. Fred Guedry established the lab as a leader in the field throughout the latter half of the 20th century. However, a substantial loss of scientific staff associated with the lab's 2010 move to WPAFB led to a much reduced vestibular research capability. Now, new facilities and the re-establishment of a core of expert researchers are the catalysts for this resurgence.

Today, the lab features several important research devices at the Dayton facility. The Visual-Vestibular Sphere Device (VVSD) contains a rotating chair surrounded by a rotating enclosed sphere designed for conducting basic research on vestibular and visual interactions. The Vertical Linear Accelerator affords up to 20 feet of vertical motion, while the Neuro-Otologic Test Center provides a precisely programmable rotating chair in a light-tight chamber. Most significantly, the lab received the long-awaited Disorientation Research Device, or the KrakenTM in October 2016. The KrakenTM is a six axis-of-motion research device that will support a range of basic and applied research on vestibular and acceleration effects. Data collection began on the first research project to use the Kraken™, June 2018, as part of a joint effort with NASA Langley Research Center to investigate and mitigate pilot spatial disorientation in commercial aviation.

Even more important than facilities to the resurgence of vestibular research is the re-establishment of a core of expert researchers. A series of motion sickness studies now led by Lt. Cmdr. Matt Doubrava, identified an intranasal formulation of scopolamine as a promising countermeasure. Lt. Adam Biggs, research psychologist, established a new capability studying the effects of virtual reality and augmented reality displays on motion or cyber sickness.

We recently welcomed a world-leading vestibular researcher to our ranks, Dr. Dan Merfeld, formerly of Massachusetts Eye and Ear Institute at Harvard Medical School and jointly recruited by NAMRU-Dayton and The Ohio State University (OSU) now serves as NAMRU-Dayton's senior vestibular scientist through an Intergovernmental Personnel Act appointment from the OSU Department of Otolaryngology at the OSU School of Medicine.

Dr. Merfeld is working alongside our researchers, including Dr. Henry Williams, supervisory research psychologist and Capt. Richard Folga, aerospace physiologist, to develop vestibular models of pilot spatial orientation. Dr. Merfeld is expanding the reach of the lab, helping to recruit several visiting scientists and establish research collaborations with leading vestibular researchers at Massachusetts Institute of Technology, Johns Hopkins University, Brandeis University, and the University of Colorado. Further, Dr. Merfeld is taking on the principal role in a joint initiative NAMRU-Dayton is pursuing with OSU to formally recognize and promote central and southwest Ohio as a national-level center for vestibular research through the capabilities of OSU, NAMRU-Dayton, and other institutions, such as the U.S. Air Force 711th Human Performance Wing at WPAFB.

NAMRU-Dayton and OSU are developing a framework to address clinical issues such as balance dysfunction and dizziness, and operational issues such as motion sickness and pilot spatial disorientation. In support of this initiative NAMRU-Dayton and OSU are organizing a vestibular oriented research conference to be held in Dayton, Ohio, spring 2019.

The Naval Aerospace Medical Research Laboratory is equipped with capabilities in acceleration and sensory science, biomedical, and engineering and technical services, all of which are supported by a unique collection of state-of-the-science research devices. Our unique research portfolio enables researchers to transition validated knowledge and effective technologies to the fleet, mitigating and preventing leading factors associated with aeromedical mishaps.

Story Link

Commanding Officer's Corner

By: Captain Rees Lee, Commanding Officer, NAMRU-Dayton

War is a fundamentally human endeavor with success or failure dependent on a force's ability to integrate human beings at all levels, from the frontline Marine to the senior admiral in the command center, seamlessly with the current technologies of warfare. Technology alone has never been and never will be sufficient to win on the battlefield. The Marine Corps Doctrinal Publication 1 "Warfighting" states it well: "War is shaped by human nature and is subject to the complexities, inconsistencies, and peculiarities which characterize human behavior… No degree of technological development or scientific calculation will diminish the human dimension in war. Any doctrine which attempts to reduce warfare to ratios of forces, weapons, and equipment neglects the impact of the human will on the conduct of war and is therefore inherently flawed."

NAMRU-Dayton is fighting the next war today by maximizing the human element. The pages of this newsletter describe the battles our scientists are fighting everyday with the goal of creating knowledge and products which will maximize the performance of our warfighters in the austere environments of future battlefields. The Environmental Health Effects Laboratory (EHEL) continues its 60 year tradition of exploring the effects of environments made hazardous by chemicals, noise, dust, fumes, pressure and abnormal oxygen concentrations. Most battlefields have more than one of these exposures and the studies of Dr. Andrew Keebaugh (p.2) involving combined sound and chemical exposure is a pivotal example. The new battlefield will also present novel exposure risks never seen before such as lasers to which Dr. Mike Reddix and Lt. Cmdr. Micah Kinney are developing mitigating strategies (p. 1).

Technology is advancing at an exponential rate. In and of itself, modern technology creates its own austere environment into which the human being must be optimally integrated. As an example, modern aircraft now have previously unimagined flight capabilities as well as using novel life support systems both of which place stresses on the human being which are just recently being recognized. Together with EHEL (p. 4), the Naval Aerospace Medical Research Laboratory's (NAMRL) Environmental Physiology team has dramatically expanded its research portfolio over the last year as part of the Navy's response to investigating physiologic episodes affecting both Navy and Air Force tactical aircraft (p. 3). A full understanding of the physiologic effects of modern aircraft on the aircrew, including the vestibular effects being investigated by Drs. Dan Merfield, Henry Williams and Capt. Richard Folga (p. 5), will be a prerequisite to Naval Aviation's long-term success. The full realization of the human-machine team's potential will be dependent not only on the machine's capabilities but also the human being's ability to process and act on increasing amounts of information. Understanding the neurophysiology of the brain and developing interventions, such as transcranial direct current stimulation (tDCS) being studied by Dr. Joyce Rohan (p. 5), promise to be breakthrough technologies which improve human performance where it most counts.

I believe that our ability to remain pre-eminent on the battlefield depends on giving our people every advantage. NAMRU-Dayton is dedicated to maximizing our warfighter's performance for tomorrow's technologically complex battlespace. The next war is already being fought today with the frontlines being manned by the scientists at NAMRU-Dayton.

Naval Medical Research Unit Dayton

NAMRU-Dayton is a major Department of Defense medical research command and the home of the Naval Aerospace Medical Research Laboratory and the Environmental Health Effects Laboratory.

NAMRU-Dayton conducts aerospace medical and environmental health effects research to enhance warfighter health, safety, performance and readiness.

Capt. Rees L. Lee
MC, USN
Commanding Officer

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